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THE IMPACT OF GAME-BASED TEACHING PRACTICES IN DIFFERENT CURRICULA ON ACADEMIC ACHIEVEMENT

Research Article

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Abstract

The study aimed to identify the impact of game-based teaching practices available in different curricula on academic achievement. The study adopted meta-analysis method via grouping similar studies about that subject, theme under the heading of certain criteria, and combining the quantitative data obtained. For this purpose, 412 studies conducted between the years of 2000-2020 were examined and 54 experimental studies on the game-based teaching practices were included in the study. The data of 54 experimental studies were analyzed via the Comprehensive Meta-Analysis Program (CMA) and MetaWin programs. The study results revealed that the game-based teaching practices applied in different curricula affect the students' academic achievement positively compared to traditional practices. The effect sizes of game-based curricula were identified to significantly differ across education levels, treatment duration, sample sizes and publication types.

Keywords: Academic achievement, curricula, game, Instruction, meta-analysis.

1. Introduction

Turkish Language Association defines the concept of a game as "entertainment that develops talent and intelligence, that has certain rules and that helps to have a good time" (Turkish Language Association [TLA], 2020). Upon examining the studies conducted on game, the concept of game is defined by researchers in various ways. While Kinzie and Joseph (2008) defined game "as an immersive, voluntary and fun activity in which a challenging goal is pursued according to the agreed rules" (p. 644), Aarseth (2014) stated that "Games are the facilitators that structure player behavior and whose main goal is enjoyment."(p. 181).

Games can be classified according to various features they contain. Game elements such as the age range the game appeals to (infant age games, early childhood games, children's games, youth games, adult games), the development area it develops (cognitive games, physical games, language games, social games, games based on self-care skills), the feature of the place where it is played (indoor games, outdoor games) allow them to be divided into their types. Thanks to the transdisciplinary method, games can take place between different genres at the same time according to a variety of characteristics. For instance, imitation play can be classified as social games and free games as well as childhood games. In this regard, games can be classified with different angles although there are no clear rules determining the types of games (Bardak, 2018).

Thinkers such as Froebel, Dewey, Montessori, Quantilianus, Locke, Aristotle, Comenius, Pestalozzi, Piaget, Rousseau and Vygotsky have accumulated considerable knowledge in the historical process with their views on the necessity, significance and benefits of the game. With the emergence of Piaget's cognitive and Vygotsky's social-cultural based game approaches, the

place and significance of the game in human life have drawn great attention in time. In this context, although game is an interdisciplinary subject of study, its effects on the processes of formation of the mind, the definition of culture, and the shaping of the self have been discussed (Nicolopoulou, 1993).

A game is known to be a key role in the lives of not only humans but also all living things. Games, which are beneficial for different purposes for people of all ages, have fundamental contributions to the education and development of individuals. In this sense, games had to be integrated in curricula not only as an entertainment tool but also as an educational tool (Malta, 2010). The game has a significant place in terms of educational science and it is a real educational tool. However, some societies that attach importance to formal education do not consider it as a productive activity and therefore do not include it in their education systems (Aral, 2010).

The Game Based Learning Model, which concentrates on the learning of individuals by playing, was developed by Garris, Ahlers and Driskell (2002). Game-based learning model consists of input, process and output parts. Instructional contents and game characteristics constitute the input while the game cycle in the process part, and learning outcomes in the output. The instructional contents and game characteristics in the input are blurred in the process of the game cycle. The game cycle begins with the action of the player. Feedback is presented to the individual within the game cycle as a result of the player's action. In this way, the individual begins to discover the structure of the game and adapt to this structure. Based on the game cycle, the individual must carry out the inquiry process in order to reach the outputs. During the inquiry process, the individual adapts and applies what they learn in the game to their real life. Individuals who can successfully complete the inquiry process gain learning outcomes (Garris, Ahlers, & Driskell, 2002). Individuals discover new knowledge in the light of the knowledge they have with a view to achieving learning outcomes in game-based learning environments. In this process, individuals who compare their prior knowledge with their new knowledge add new information on top of their old knowledge to produce different and new solutions. This characteristic of the game-based learning model indicates that the individual can access new knowledge through observation, research, and questioning in a way that is far from memorizing (Türkmen, 2017).

1.1. The Significance of Game-Based Teaching

Considering the educational outcomes of learning by playing, many scientific studies revealed that educational games are an effective learning tool (Chen, Wang and Lin, 2015; Hwang, Wu, Chen, 2015; Papastergiou, 2009; Virvou, Katsionis and Manos, 2005). Besides, game-based activity processes were mentioned to not only increase the learning motivation of individuals (Yang, 2012; Virvou, Katsionis, & Manos, 2005; Hwang, Wu, Chen, 2015;), but also provide individuals with interactive learning opportunities (Prensky, 2001). In this context, the advantages of game-based learning were found to be interesting and motivating (Doğusoy & İnal, 2006), that the targeted knowledge and skills can be easily gained to individuals thanks to the learning environments that become fun and enjoyable (Güngörmiş, 2007), and problem-solving skills based on research and inquiry can be developed (Doğusoy & İnal, 2006), opportunities for learning by learning by doing are offered (Aksoy, 2014) and can increase the quality of education when applied effectively (Bağcı & Çoklar, 2014). Despite the advantages of game-based learning environments, some scientific studies concluded that there are also possible disadvantages which are the need for large investments in terms of resources and time for an effective game-based learning environment (Aksoy, 2014; Bayırtepe & Tüzün, 2007), the need for more control than traditional learning environments, difficulties in carefully

determining the suitability of the designed games to the age levels of the individuals by the educator (Ocak, 2013), individuals focusing only on the enjoyment factor and not adopting the educational outcomes of the game (Şahin, 2015).

Upon analyzing the relevant literature, the studies showed that a variety of game based teaching practices conducted experimentally within different curricula in Turkey and abroad positively affect the students' academic achievement. These studies were carried out in such curricula as physical education and game teaching (Zetou et al., 2014;), computer and instructional technologies (Bayırtepe & Tüzün, 2007), geography (Chen, Yeh, & Chang, 2015; attention (Gözalan, 2013;), language skills (Uyanık and Alisinanoğlu, 2016,) science (Al-Tarawneh, 2016; Gazeteci, 2014; Güner, 2018; Sung & Hwang, 2013; Şahin, 2015; Tokgöz, 2017; Tut, 2018), English (Gömleksiz, 2005), mathematics (Bozoğlu, 2013; Chang et al., 2012; Çelik and Kandır, 2013; Hung, Huang & Huwang, 2014; King, 2011; Sevigen, 2013; Türkmen, 2017; Yiğit, 2007; Weis, Kramarski & Talis, 2007) and music (Ayan & Kaya, 2016). The studies emphasized that game-based teaching practices applied in curricula improve students' motivation, willingness to learn, curiosity and different skills. In this regard, this study aims to identify the impact of game-based teaching practices available in different curricula upon academic achievement through meta-analysis. In addition, the effects of different variables (education levels, treatment duration, publication types and sample sizes) on academic achievement were also examined.

2. Method

2.1. Research Model

The study adopted the meta-analysis method in order to examine the effect of game-based teaching on students' academic achievement. The meta-analysis method aims at grouping similar studies about a subject, theme or study under the heading of certain criteria and combining as well as interpreting the quantitative findings for these studies (Sterne, Gavaghan & Egger, 2000). Meta-analysis studies include combining a series of studies obtained from similar studies under a common heading through statistical analysis (Hedges, 1992). In this sense, the main purpose of meta-analysis studies is to combine the results obtained from different studies to obtain a general result (Dinçer, 2014). Meta-analysis studies have a sequential process that includes defining the research problem, structuring the theoretical framework, systematic coding of the obtained data and the data analysis by transforming it into a common scale (Glass, 2006).

2.2. Data Collection Procedure

In this study, different experimental studies involving game-based learning between the years of 2000-2020 were examined. The first research was reached on June 5, 2019, and the last one on December 1, 2020. The steps followed in this study can be presented as follows (Borenstein, Hedges, Higgins & Rothstein, 2009; Dinçer, 2014):

1. *Identification of the subject*: The subject of this study was addressed as the analysis of the effect of game-based teaching on students' academic achievement.

2. *Establishing the theoretical framework:* 412 studies on the research subject were found by scanning the databases of Turkish Higher Education Council National Thesis Center,

Google Academic, Proquest, British Education Index, Scopus, Eric, Australia Education Index, Web of Science (SCI-Exp. / SSCI / AHCI).

3. *Determination of Criteria*: The studies with post-test scores of experimental and control groups from true experimental and semi-experimental studies were taken into consideration as research criteria.

4. *Identification of the variables related to the research subject:* The study variables were determined by considering the theoretical framework. In this framework, the education level, sample size, type of publication and duration of treatment were determined as the variables of the study.

5. *Determination of research questions:* The themes that form the basis of the research questions were determined in this step. After the themes were determined, the research questions were included depending on the research topic and variables.

6. *Creating codes based on themes:* After the themes were determined in the context of the research questions, each study was grouped and coded under themes.

7. *Performing the analyzes*: The data analysis was performed through use of Comprehensive Meta-Analysis (CMA) and MetaWin analysis programs.

8. *Calculation of the effect coefficient*: The pre-test and post-test scores were examined several times by two different data encoders in order to calculate the effect coefficient, and the procedure was performed depending on the findings of the same data type.

9. *Heterogeneity test:* The data to be obtained as a result of the heterogeneity test is a significant factor in choosing the model for calculating the overall effect. After the effect sizes of the individual studies were calculated, the heterogeneity test was carried out by means of meta-analysis software (CMA and MetaWin). The heterogeneity test results showed that the p-value was less than .05 or the Q value was greater than the df value in the X^2 table, meaning that the analyzed studies were heterogeneous. The p and Q values obtained as a result of the heterogeneity test suggested that the data were heterogeneous in the current study. In this context, the analyzes were made according to the random effects model.

10. *Calculation of the general effect:* The findings obtained as a result of the heterogeneity test revealed the model to be selected. This study used random effects model based upon heterogeneity test results.

2.3. Criteria

The studies included in the meta-analysis study consisted of those aiming to determine the students' academic achievement in game-based teaching practices in different curricula. The research criteria both prevented publication bias and increased the quality of meta-analysis studies. In this framework, the following criteria were taken into account (Batdı, 2014):

1. The studies examining the effect of game based teaching in different curricula in Turkey and abroad between 2000-2020 on student achievement were included in the study. However, abstracts or full text proceedings presented in symposiums, congresses etc. were not taken into consideration.

2. The studies in which experimental groups consisted of game-based teaching and control groups included traditional practices other than game-based education were taken into consideration.

3. Studies showing the sample size (N), posttest arithmetic mean (*X*) and standard deviation scores (Sd) of experimental and control groups were taken into account. In addition, those that indicate the sample size (N) and t value or sample size and (p) value of the experimental and control groups were also considered. Moreover, the study included and examined some studies presenting the arithmetic mean (*X*) and (p) values of post-test scores of experimental and control groups.

4. In the studies with more than one post-test, experimental or control group, one of the data was included in the study by following the random path.

5. The studies were searched on the databases such as Web of Science (SCI-Exp. / SSCI / AHCI), Turkey HEB National Thesis Center, ERIC, SCOPUS, British Education Index, Australian Education Index, ProQuest and Google academic. Key words such as "Game", "Game-based teaching", "Playground" were used to obtain the data. In this regard, 892 studies covering game-based teaching in different curricula were achieved. Of these studies, 842 studies were excluded as they did not meet the specified criteria. Thus, 54 studies that met the research criteria were found to be eligible during the analysis process.

2.4. Variables

The effect size of each study aiming to determine the effectiveness of the game-based teaching practices in different curricula were indicated as the dependent variable of the study having emerged as a result of statistical analysis. The dependent variables (study characteristic) of this study are given as follows (Bernard et al., 2004):

1. *Education level:* In this theme, the education levels were coded as preschool education, primary school and secondary school.
2. *Treatment duration:* Treatment duration was coded as two themes, studies conducted in 1-5 weeks and those over 5 weeks.
3. *Sample size*: The sample sizes were coded into two themes as studies with sample sizes of 1-60 and over 60.
4. *Publication type:* This theme was coded as two -article and postgraduate theses.

2.5. Data coding

The elicited data depending on the research theme were collected in a common file by examining different databases in electronic environment. Depending on the research theme, a certain coding list was created in a word document. The coding list was divided into two parts. The first part of this list included the surnames of the researchers and the publication date of the research, variables (education levels, treatment duration, sample sizes and publication types). The second part of the coding list included arithmetic mean (), standard deviation (Sd), dependent sample t values and significant difference values (p), sample numbers (N) and effect sizes related to the experimental and control group posttest scores of the studies.

2.6. Data Analysis

CMA and MetaWin meta-analysis data programs were utilized during data analysis. Therefore, the effect sizes of these studies were calculated by considering the data of each study in detail. In meta-analysis applications, Hedges'g and Cohenn's d meta-analysis applications are the coefficients used in the calculation of effect sizes (Borenstein et al. 2009).

Despite the use of different formulas, the results of the operations performed according to Hedges'g and Cohen's d coefficients were similar. In the study Hedges' g coefficient in calculating the effect sizes of the data was used.

3. Findings

Considering the whole of 54 studies comparing game-based experimental studies in different curricula, 1876 students were found to constitute the experimental group while 2125 students the control group. Table 1 depicts the percentage (%) and frequency (f) values of the independent variables in the study.

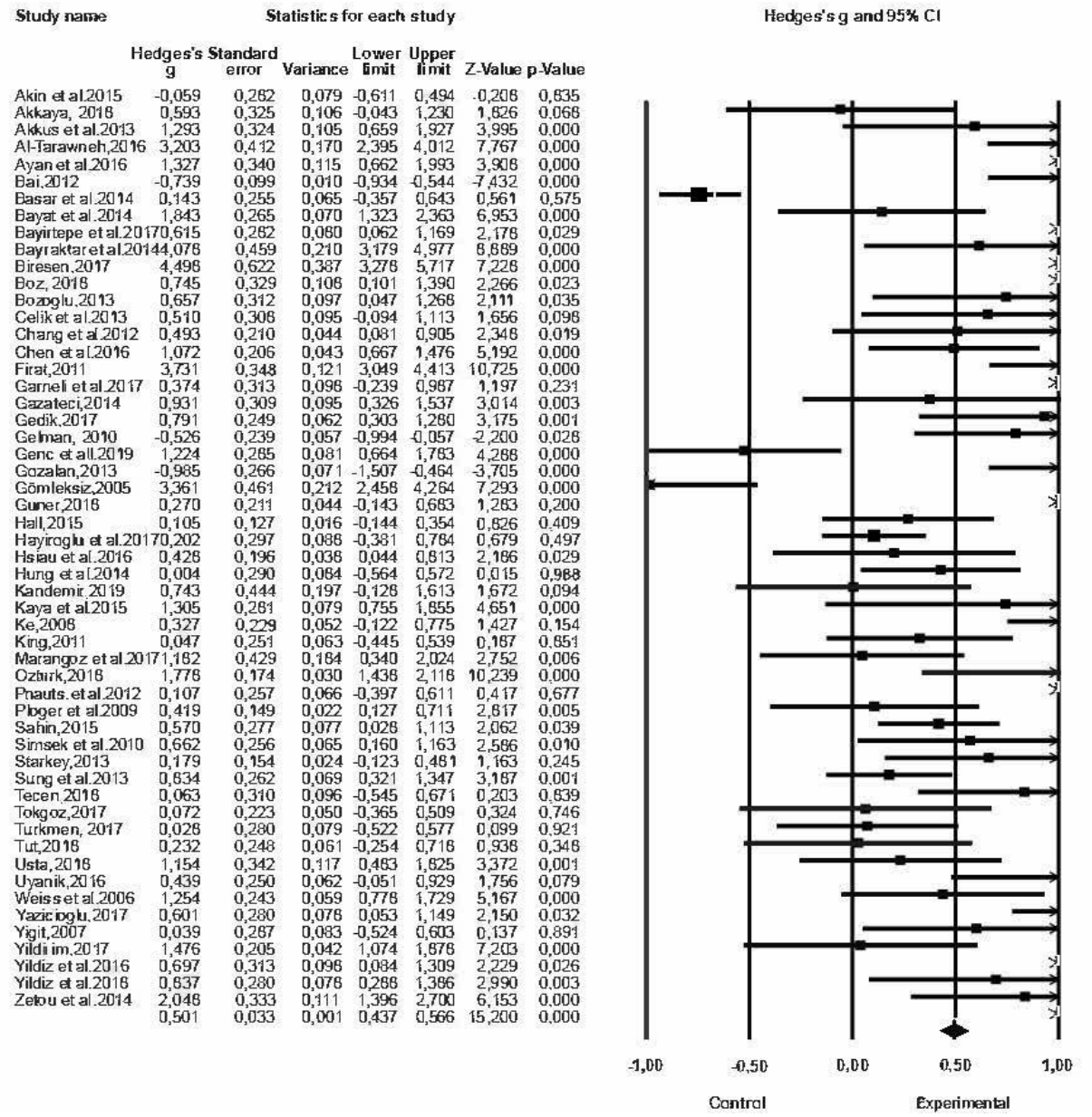
Table 1. *The independent variables and statistical distributions of the studies*

Variable	Frequency (f)	Percentage (%)
Education Level		
Preschool	11	20.37
Primary	16	29.63
Secondary	27	50
Sample Size		
1-49	19	35.18
50 -99	25	46.29
100 and over	10	18.53
Treatment Duration		
1-5 weeks	29	53.70
More than 5 weeks	25	46.30
Publication types		
Thesis	19	35.18
Article	35	54.82

Table 1 revealed that half of the studies were conducted at the secondary school level (50%). There were also studies carried out at primary school (29.32%) and pre-school (20.37%) education levels. Considering the sample sizes of the studies, 19 studies were identified to have sample sizes between 1-49 (35.18%) while 25 of them had a sample size between 50-99 (46.29%). Besides, there were 10 studies (18.53%) with 100 or more samples. While 29 studies (53.70%) were found to have 1-5 week-treatment duration, 25 studies (46.30%) were conducted for more than 5 weeks. Upon analyzing the publication types, 35 studies (54.82%) were determined to be articles and 19 studies (35.18%) were theses.

3.1. Study effect sizes

Hedges'g values, impact directions, standard error and variance values of the studies considered within the scope of the research are shown in Figure 1.



Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Akin et al.2015	-0,059	0,262	0,079	-0,611	0,494	-0,208	0,835
Akkaya, 2018	0,593	0,325	0,106	-0,043	1,230	1,826	0,068
Akkus et al.2013	1,293	0,324	0,105	0,659	1,927	3,995	0,000
Al-Tarawneh,2016	3,203	0,412	0,170	2,395	4,012	7,767	0,000
Ayan et al.2016	1,327	0,340	0,115	0,662	1,993	3,908	0,000
Bai,2012	-0,739	0,099	0,010	-0,934	-0,544	-7,432	0,000
Basar et al.2014	0,143	0,255	0,065	-0,357	0,643	0,561	0,575
Bayat et al.2014	1,843	0,265	0,070	1,323	2,363	6,953	0,000
Bayirtepe et al.2017	0,615	0,262	0,069	0,062	1,169	2,178	0,029
Bayraktar et al.2014	4,078	0,459	0,210	3,179	4,977	8,889	0,000
Biresen,2017	4,498	0,622	0,387	3,278	5,717	7,228	0,000
Boz, 2018	0,745	0,329	0,108	0,101	1,390	2,266	0,023
Bozoglu,2013	0,657	0,312	0,097	0,047	1,268	2,111	0,035
Celik et al.2013	0,510	0,306	0,095	-0,094	1,113	1,656	0,098
Chang et al.2012	0,493	0,210	0,044	0,081	0,905	2,348	0,019
Chen et al.2016	1,072	0,206	0,043	0,667	1,476	5,192	0,000
Firat,2011	3,731	0,348	0,121	3,049	4,413	10,725	0,000
Garneli et al.2017	0,374	0,313	0,098	-0,239	0,987	1,197	0,231
Gazateci,2014	0,931	0,309	0,095	0,326	1,537	3,014	0,003
Gedik,2017	0,791	0,249	0,062	0,303	1,280	3,175	0,001
Gelman, 2010	-0,526	0,239	0,057	-0,994	-0,057	-2,200	0,028
Genc et all.2019	1,224	0,285	0,081	0,664	1,783	4,288	0,000
Gozalan,2013	-0,985	0,266	0,071	-1,507	-0,464	-3,705	0,000
Gömleksiz,2005	3,361	0,461	0,212	2,458	4,264	7,293	0,000
Guner,2018	0,270	0,211	0,044	-0,143	0,683	1,283	0,200
Hall,2015	0,105	0,127	0,016	-0,144	0,354	0,826	0,409
Hayiroglu et al.2017	0,202	0,297	0,088	-0,381	0,784	0,679	0,497
Hsiau et al.2016	0,428	0,196	0,038	0,044	0,813	2,186	0,029
Hung et al.2014	0,004	0,290	0,084	-0,564	0,572	0,015	0,988
Kandemir,2019	0,743	0,444	0,197	-0,128	1,613	1,672	0,094
Kaya et al.2015	1,305	0,281	0,079	0,755	1,855	4,651	0,000
Ke,2008	0,327	0,229	0,052	-0,122	0,775	1,427	0,154
King,2011	0,047	0,251	0,063	-0,445	0,539	0,187	0,851
Marangoz et al.2017	1,182	0,429	0,184	0,340	2,024	2,752	0,006
Oztirk,2018	1,778	0,174	0,030	1,436	2,116	10,239	0,000
Phauts.et al.2012	0,107	0,257	0,066	-0,397	0,611	0,417	0,677
Ploger et al.2009	0,419	0,149	0,022	0,127	0,711	2,817	0,005
Sahin,2015	0,570	0,277	0,077	0,028	1,113	2,062	0,039
Simsek et al.2010	0,662	0,256	0,065	0,160	1,163	2,586	0,010
Starkey,2013	0,179	0,154	0,024	-0,123	0,481	1,163	0,245
Sung et al.2013	0,834	0,262	0,069	0,321	1,347	3,187	0,001
Tecen,2018	0,063	0,310	0,096	-0,545	0,671	0,203	0,839
Tokgoz,2017	0,072	0,223	0,050	-0,365	0,509	0,324	0,746
Turkmen, 2017	0,028	0,280	0,079	-0,522	0,577	0,099	0,921
Tut,2018	0,232	0,248	0,061	-0,254	0,718	0,938	0,348
Usta,2018	1,154	0,342	0,117	0,483	1,825	3,372	0,001
Uyanik,2016	0,439	0,250	0,062	-0,051	0,929	1,756	0,079
Weiss et al.2006	1,254	0,243	0,059	0,778	1,729	5,167	0,000
Yazicioglu,2017	0,601	0,280	0,078	0,053	1,149	2,150	0,032
Yigit,2007	0,039	0,287	0,083	-0,524	0,603	0,137	0,891
Yildiim,2017	1,476	0,205	0,042	1,074	1,878	7,203	0,000
Yildiz et al.2016	0,697	0,313	0,098	0,084	1,309	2,229	0,026
Yildiz et al.2018	0,837	0,280	0,078	0,288	1,386	2,990	0,003
Zetou et al.2014	2,048	0,333	0,111	1,396	2,700	6,153	0,000
	0,501	0,033	0,001	0,437	0,566	15,200	0,000

Figure 1. The effect direction, standard error and variance values of the studies

Taking the diagram in Figure 1 into account, the value ranges of 50 studies examined within the scope of meta-analysis were found to differ across 4.498 and -0.985. While 46 studies had a positive effect size, 4 studies had a positive effect size. The study with the largest confidence interval was the one conducted by Biresen (2017), whereas the study with the narrowest confidence interval was conducted by Hung, Huang, and Hwang (2014). 50 (92.59%) of 54 studies demonstrated that game-based teaching practices in different curricula positively affects the students' achievement.

3.2. Publication bias statistics

In the study, seeking the effect of game-based practices applied in different curricula on the academic achievement of the students, Funnel Plot (Funnel plot) graph was examined and the Rosenthal FSN value and Begg and Mazumdar rank correlation statistics were analyzed. The results of this analysis are displayed below.

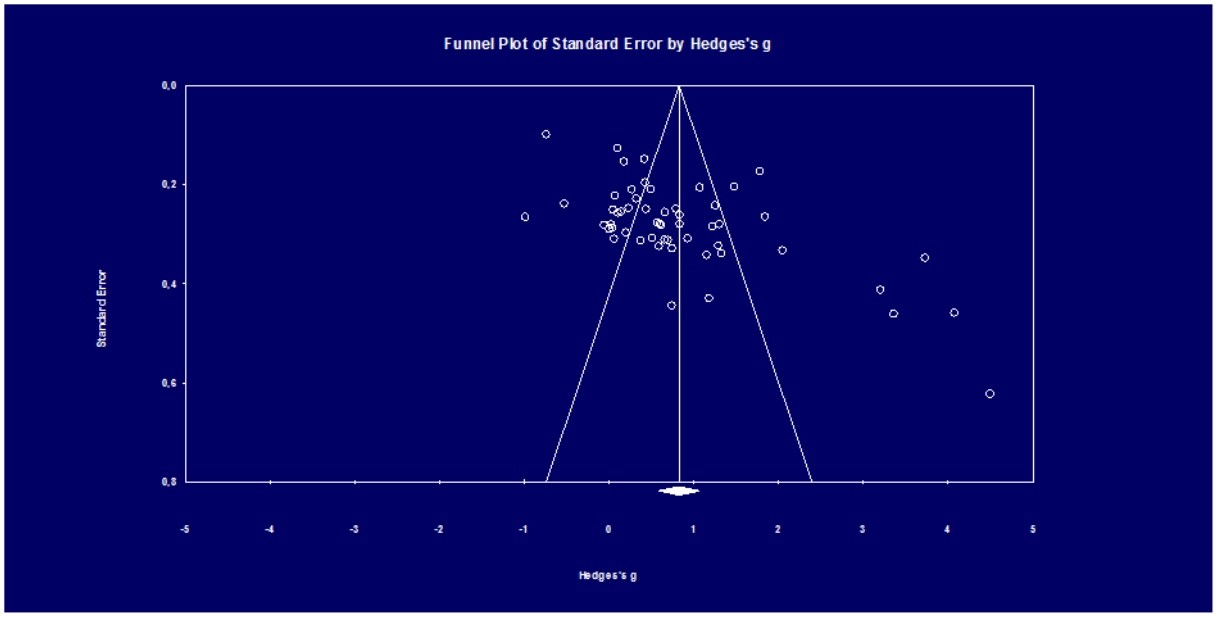


Figure 2: Effect size funnel plot

In funnel charts, effect size is shown on the horizontal (X) axis, and sample size or variance on the vertical (Y) axis (Sterne & Harbord, 2004). As can be seen in the figure, most of the studies were found to be in the funnel and the data were symmetrically distributed. Rosental FSN and Begg Mazumdar rank Correlation values (Dinçer, 2014) were also examined as the effect size funnel plot would not be sufficient alone in determining the publication bias.

Table 2. Rosental FSN values determined for 54 studies examining the effect of game-based practices in different curricula on students' academic achievement.

Z-value for observed studies	19.58130
P-value for observed studies	0,000000*
Alpha	0.05
Directions	2
Z value for alpha	1.95996
Number of the observed studies	54
FSN	5336

Considering the analysis results in Table 2, the statistical significance value of p = .000 depends on the existence of 5336 studies with effect size in order to be p <.05. The Rosental FSN value was noted to be higher than the number of studies examined within the scope of the analysis. Therefore, it may be wise to mention that the study is resistant to publication bias (Rosenthal, 1991). In other words, the calculated value reveals the number of publications required for the meta-analysis result to become meaningless. This value is determined using the formula N/ *(5k+10)*. If the value calculated here exceeds the critical value of 1, it indicates that the meta-analysis is sufficiently resistant for further studies (Mullen, Muellereile, & Bryant, 2001). The determination of the value obtained from this study as 19.05 as a result of

the analyzes performed via the Rosental method indicates that the meta-analysis results are highly resistant to primary research to be conducted on similar subjects.

3.3. Distribution of the studies examined in the context of meta-analysis according to effect models

Average effect sizes (ES), degrees of freedom (df) and total heterogeneity values (Q) and confidence intervals for effect sizes according to fixed and random effect models are depicted in Table 3.

Table 3. Average effect sizes and homogeneity values according to model types

Model Type	N	Z	Q	ES	Confidence Intervals	
					Lower Limit	Upper Limit
Fixed Effects Model (FEM)	54	15.2		.501	.437	.566
Random Effects Model (REM)	54	6.72	701.869	.826	.585	1.067

The analyzes performed according to the fixed effect model suggested that the standard error value was calculated as .033, the lower limit of the 95% confidence interval was determined as .437 and the upper limit as .566. In addition, the effect of game-based practices on academic achievement in different curricula can be said to be positive with a value of .501 according to the fixed effects model. This value was accepted as ($X^2_{(0.95)}$ = 72.153) at .05 significance level and 53 degrees of freedom in the chi square (X^2) table in terms of the Q statistical value 701.869.

Since the Q statistical value (Q=701.869) was greater than the critical value (Q=71.153) in the present study, the effect size value was heterogeneous. In this regard, analyzes were carried out based upon the random effects model due to the heterogeneous nature of the data. The fact that the effect size value was (ES =.82) in the analyzes made according to the random effects model indicated that game-based teaching practices in different curricula are more effective than traditional practices and this difference is significant. The effect size (ES=.82) was at a medium level in this study (Cohen et al., 1992).

3.4. An analysis of game-based teaching practices in different curricula according to the education level variable

The studies under the title of this variable were divided into three parts in order to determine the effect sizes of the studies conducted within the scope of game-based teaching practices. These were preschool education, primary school and secondary school. Table 4 suggests the analyzes performed according to these subgroups.

Table 4. Effect sizes according to education levels

Education level	N	ES	%95 confidence interval for the effect size	
			Lower limit	Upper limit
Preschool	11	.614	.442	.787
Primary	16	.693	.576	.810
Secondary	27	.369	.281	.457

As is seen in Table 4, the highest effect size (ES =.576) was determined in preschool education, and the lowest effect size (ES =.281) at the secondary school level. Q statistic value was calculated as (Q_b =20.501) in terms of the homogeneity test. The 95% significance level and 53 degrees of freedom were calculated as 20.501 ($X^2_{(0.95)}$= 20.501) by taking into account the chi square (X2) table. With 53 degrees of freedom at a 95% significance level from the chi square (X2) table, the critical value was accepted as 72.153. Since the Q statistical value 20.501 was less than 72.153, which is the critical value, the homogeneity test for the effect size was accepted in the random effects model. The effect sizes were identified to significantly vary across education level since the effect sizes were (Q_b = 20.501,p<.05) between groups determined according to education levels.

3.5. An analysis of game-based teaching practices in different curricula according to the treatment duration variable

With the aim of determining the total effect sizes of the studies conducted in the context of game-based teaching practices, the studies were listed under two sub-headings. One of them was experimental studies applied between 1-5 weeks. Another sub-heading covered the experimental studies applied in more than 5 weeks. The analyzes performed according to these subgroups are depicted in Table 5.

Table 5. Effect sizes according to treatment duration

Treatment duration	N	ES	%95 confidence interval for the effect size	
			Lower limit	Upper limit
1-5 weeks	29	.670	.486	.942
5 weeks and over	25	.347	.550	1.439

Table 5 shows that the effect size (ES =.995) of the practices performed for 5 weeks or more according to the treatment duration of the game-based teaching practices in different curricula was determined to be higher than those performed between 1-5 weeks (ES =.714). Q statistic value was calculated as (Q_b =23.532) according to the homogeneity test. This value was accepted as 72.153 at 95% significance level and 53 degrees of freedom according to the chi square (X^2) table ($X^2_{(0.95)}$= 72.153). With the statistical value of 23.532, the chi-square distribution at 53 degrees of freedom was found to remain below the critical value ($X^2_{(0.95)}$ = 72.153). In line with these values, the effect size distributions of the studies may be said to have a homogeneous structure. Hence, the study findings were evaluated according to the fixed effects model. The effect sizes between the groups were determined to significantly differ across the treatment duration of the experimental studies (Q_b = 23.532, p < .05).

3.6. An analysis of game-based teaching practices in different curricula according to the publication type variable

The studies were examined under two sub-headings as articles and theses with the intent of determining the total effect sizes of the studies conducted within the scope of game-based teaching practices in terms of publication type. The distribution of the findings regarding these variables is presented in Table 6.

Table 6. Effect sizes according to publication types

Publication types	N	ES	%95 confidence interval for the effect size	
			Lower limit	Lower limit
Articles	35	.564	.484	.644
Theses	19	.384	.270	.498

Given the publication types of the studies conducted within the scope of game-based teaching practices, the effect size of the articles (ES =.564) was noted to be higher than that of the theses (ES =.384). Considering the homogeneity test, the Q statistic value was determined as (Q_b =6.45). This value was determined as 72.153 at 95% significance level and 53 degrees of freedom from the chi square (X^2) table ($X^2_{(0.95)}$= 72.153). The statistical value of Q was 6.45 with 53 degrees of freedom which is below the critical value of the chi-square distribution ($X^2_{(0.95)}$ = 72.153). Based upon these values, it was determined that the effect size distributions of the studies were homogeneous, and the findings were evaluated according to the fixed effects model. The effect sizes between the groups were identified to have significant differences in terms of publication types of the studies (Q_b = 6.45, p < .05).

3.7. An analysis of game-based teaching practices in different curricula according to the sample size variable

The total effect sizes of the studies conducted within the framework of game-based teaching practices were examined in terms of sample size as 1-49, 50 -99 and 100 or over. Table 7 presents the distribution of the findings regarding these variables.

Table 7. Effect sizes according to sample size

Sample size	N	ES	%95 confidence interval for the effect size	
			Lower limit	Lower limit
1-49	19	.702	.550	.854
50 -99	25	.693	.587	.799
100 and over	10	.252	.158	.356

Table 7 indicates that the group with the highest effect size in the sample size variable of game-based teaching practices applied in different curricula was the variables with samples between 1-49 (ES =.702). The group with the lowest effect size was the variable with 100 or over samples (ES =.252). The homogeneity test results pointed that the Q statistic value was (Q_b= 42.609). This value was determined as 72.153 with 53 degrees of freedom at a 95% significance level as in the chi square (X^2) table ($X^2_{(0.95)}$= 72.153). In this context, the statistical value of Q was below the critical value ($X^2_{(0.95)}$ = 72.153) of the chi-square distribution at 53 degrees of freedom with 42.609. These values suggested that the effect size distributions of the studies were homogeneous, and the elicited findings were evaluated in terms of the fixed effects model. The effect sizes between the groups were found to significantly vary across the sample size of the studies (Q_b = 42.609, p < .05).

4. Discussion, Conclusion and Recommendations

This study attempts to examine the effects of game-based practices in the curricula of different education levels (preschool, primary school and secondary school) on the students' academic achievement. Studies indicated that game-based teaching practices support students' development and skills, and they also offer them different learning opportunities (Al-Tarawneh, 2016; Bai, 2012; Gelman, 2010; Güner, 2018; Hayıroğlu & Ulus, 2017; Ploger & Hecht, 2009). Game-based learning also increases students' motivation for activities in the lesson (Hsiao & Chen, 2016). There is a close link between game and learning. Students learn by experiencing the activities in their curriculum through games. In this regard, games contribute to students' learning in a safe, effective and enjoyable way (Zetou et al., 2014). Game-based learning experiences emerge as a key factor that improves students' both mental and social emotional abilities (Sung & Hwang, 2013). Moreover, adapting games to curricula has a positive impact on students' psycho-motor development (Hsiao & Chen, 2016; Zetou et al., 2017). Game-based practices also positively affect students' problem-solving skills (Chang et al., 2012).

The results of this study have revealed that game-based teaching increases the students' academic achievement. The study also shows that game-based practices in different curricula play a dominant role in increasing student achievement compared to traditional practices. Game-based teaching practices have been determined to increase students' achievement in mathematics (Bozoğlu, 2013; Garneli, Giannakos, Chorianopoulos, 2017; Gelman, 2010; Hung, Huang & Hwang, 2014, King, 2011, Ploger & Hecht, 2009), science (Gazeteci, 2014; Sung & Hwang, 2013; Şahin, 2015; Tokgöz, 2017), physical education and game (Hsiao & Chen, 2016; Zetou et al., 2017), geometry (Bozoğlu, 2013), language skills (Uyanık & Sinanoğlu, 2016), geography (Chen, Yeh & Chang, 2015) courses.

Another remarkable finding of the study is that the academic achievement of the precshoool and primary school students in game-based teaching practices was higher than secondary school students. This may be due to students' high level of motivation for learning (Sung & Hwang, 2013), being more interested and curious about learning (Weiss, Kramarski, & Talis, 2006), not just enjoying games but seeing them as an educational tool (Al-Tarawneh, 2016).

When the treatment duration of game-based teaching practices in different curricula were compared, it was determined that the practices performed between 1-5 weeks increased the students' academic achievement more than those performed over 5 weeks, and this difference was found to be in favor of the practices performed between 1-5 weeks. The reasons for this may be the decrease in the students' interest and curiosity and the problems of focusing on the practices as the treatment duration extends. As the age level decreases, the students' interest in teaching practices tends to decrease.

Another result of the study is that the academic achievement of the students increases as the sample size decreases. The small number of students in teaching practices contributes to peer-to-peer learning deficiencies, mutual learning, and meaningful learning efforts through peers (Tran, 2012; Johnson, 2014). Based upon these reasons, academic achievement in game-based teaching practices may be expected to be higher in studies with a small sample size. The results also indicate that the effect sizes of the articles are at a higher level than the theses. The reasons for this can be considered as the review of the articles by the field editors of the journals and their evaluation by different referees in the relevant field.

In this study, meta-analysis was utilized. In further studies, game-based curricula can be examined through meta-thematic and mega-multiple holistic approaches.

References

(The studies marked (*) were included in the meta-analyses).

Aarseth E. (2014). I Fought the Law: Transgressive play and the ımplied player. In: Segal N. & Koleva D. (Eds.) *From Literature to Cultural Literacy.* Palgrave Macmillan, London. https://doi.org/10.1057/9781137429704_13.

*Akın, F. A., & Atıcı, B. (2015). The Effects of Game-Based Learning Environments on Student Achievement and Views. *Turkish Journal of Educational Studies, 2*(2), 75-102.

*Akkaya, S. (2018). *The effect of game based activities in improving the concept of geometry sub-learning areas of primary school fourth class mathematics course.* Unpublished Doctoral Thesis, İnönü University, Malatya.

*Akkuş Sevigen, F. (2013). *The effect of mathematical education programme based on playing, on the child's mathematical development.* Unpublished master's thesis, Hacettepe University, Ankara.

Aksoy, N. C. (2014). Effects of digital game-based mathematics teaching on 6th grades students' achievement, motivation, attitude and self-efficacy. (Unpublished doctoral dissertation). Gazi University Institute of Educational Sciences, Ankara.

*Al-Tarawneh, M. H. (2016). The effectiveness of educational games on scientific concepts acquisition in first grade students in science. *Journal of Education and Practice, 7*(3), 31-37.

Aral, N. (2000). The importance of play in child development. *Çağdaş Eğitim, 265,* 15-17.

*Ayan, B. E., & Kaya, S. (2016). The Effect of Music and Movement on Learning in Early Childhood. *Erzincan University, Journal of Education Faculty, 18*(1), 463–480.

Bağcı, H., & Çoklar, A. N. (2014). The evaluation of CEIT teacher candidates in terms of computer games, educational use of computer games and game design. *Qualifications Journal of Theoretical Educational Science, 7*(2), 195-211.

*Bai, H., Pan, W., Hirumi, A., & Kebritchi, M. (2012). Assessing the effectiveness of a 3-D instructional game on improving mathematics achievement and motivation of middle school students. *British Journal of Educational Technology, 43*(6), 993–1003. https://doi.org/10.1111/ j.1467-8535.2011.01269.x

Bardak, M. (2018). Game-based learning. In A. Gürol (Eds.), Learning Approaches in Early Childhood Period (pp. 207-230). İstanbul: Efe Academy Publications.

*Başar, M., Batur, Z., & Karasu, M. (2014). Effect of kukset technique on students' comprehension of synonym and antonym. *Kastamonu Journal of Education, 22(3),* 909–922.

Batdı, V. (2014). The effects of a problem-based learning approach on students' attitude levels: A meta-analysis. Educational Research and Reviews, *9* (9), 272-276.

*Bayat, S., Kılıçarslan, H., & Şentürk, Ş. (2014). Analysing the effects of educational games in science and technology course on seventh grade students' academic achievements. *Abant İzzet Baysal University, Journal of Education Faculty, 14*(2), 204–216.

*Bayırtepe, E., & Tüzün, H. (2007). The Effects Of Game-Based Learnıng Envıronments On Students' Achıevement And Self-Efficacy In A Computer Course. *Hacettepe University Journal of the Faculty of Education, 33*(33), 41-54.

*Bayraktar, V., & Temel, F. (2014). The effect of the program of readiness education on the skills on reading-writing skills. *Hacettepe Unıversıty Journal of Educatıon, 29(3),* 8–22.

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. Review of Educational Research, *74*, 379–439.

*Birsen, P. (2017). *Effect of gamified game-based learning on L2 vocabulary retention by young learners.* Unpublished Master's Thesis, Bahçeşehir Unıversıty, İstanbul.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. West Sussex, UK: John Wiley & Sons, Ltd.

*Boz, İ. (2018). The effect of teaching with games method on academic success in primary school 4th grade Turkish lesson. *Journal of Social Sciences and Education, 1*(1), 61–75.

*Bozoğlu, U. (2013). *The Effect of Game Based Instruction on Students' Achievement While Teaching Area-Perimeter Relationship in Mathematics at the 7 th Grade Elemantary School*. Ondokuz Mayıs University, *Samsun*.

*Can, S., & Yıldırım, M. (2017). Deal or no deal": Should science lesson be taught with instructional games? *Ataturk University, Kazım Karabekir Journal of Faculty of Education, 35*, 14–30.

*Chang, K.-E., Wu, L.-J., Weng, S.-E., & Sung, Y.-T. (2012). Embedding game-based problem-solving phase into problem-posing system for mathematics learning. *Computers & Education, 58*(2), 775–786.

*Chen, C. L. D., Yeh, T. K., & Chang, C. Y. (2016). The effects of game-based learning and anticipation of a test on the learning outcomes of 10th grade geology students. *Eurasia Journal of Mathematics, Science and Technology Education, 12*(5), 1379-1388.

Cohen, A. (1992). Antecedents of organizational commitment across occupational groups: A meta-analysis. *Journal of Organizational Behavior*, 13, 539–558.

*Çelik, M., & Kandır, A. (2013). The effect of "big maths for little kids" curriculum on mathematical development of 61–72 Month-old children. *Journal of Theoretical Educational Science, 6*(4), 551–567.

Dinçer, S. (2014). *Applied meta-analysis in educational sciences.* Ankara: Pegem A Yayıncılık.

Doğusoy, B., & İnal, Y. (2006). Learning with multiuser computer games. *VII. Paper presented at the National Science and Mathematics Education Congress,* Gazi Education Faculty, Ankara.

*Fırat, S. (2011). *The effect of mathematics teaching performed through educational computer games on conceptual learning.* Master's thesis, Adıyaman University, Adıyaman.

*Garneli, V., Giannakos, M., & Chorianopoulos, K. (2016). Serious games as a malleable learning medium: The effects of narrative, gameplay, and making on students' performance and attitudes. *British Journal of Educational Technology 48,* 842–859.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming, 33*(4), 441-467.

*Gazeteci, Ç. D. (2014). *The effect of game based learning on students' academic achievement and critical thinking skills in the primary school 8th grade science and technology lessons*. Unpublished master's thesis, Kocaeli University, Kocaeli.

*Gedik, M. (2017). The influence of educational plays on achievement and permanence in the improvement of 2th grade students' reading skills. *Atatürk University, Journal of the Institute of Turkish Studies, 58,* 453–464.

*Gelman, A. (2010). *Mario math with millennials: The impact of playing the Nintendo DS on student achievement. (PhD Dissertation),* University of Denver.

Genç, S., & Buyurgan, S. (2018). the effect of museum activities based on games to the student achievement and their attitude towards art classes. *İnönü University Journal of the Faculty of Education, 19*(3), 687–699.

*Glass, G. V. (2006). Meta-Analysis: The quantitative synthesis of research findings. In J. Green, G. Camilli & P. Elmore (Eds.), Handbook of complementary methods in education research (pp. 427-438). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Glass, G. V., McGaw, B., & Smith, M. L. (1981). *Meta-analysis in social research.* Newbury Park, CA: Sage.

*Gömleksiz, M. N. (2005).Learning English with the game application and effcet on student success: Example of Elazıg Bilgem primary school, Manas University Journal of Social Sciences , *7*(14), 179-195.

*Gözalan, E. (2013). *Effect of "Game-Based Attention Training Program", prepared by the researcher, on attention and language skills of 5 and 6 year old children.* Doctoral dissertation, Selçuk University, Konya.

*Güner, C. (2018). *The effect of game-based learning methods on students' academic achievement of Science.* Unpublished Master's Thesis, Bahçeşehir University, İstanbul.

*Güngörmüş, G. (2007). *The effect of games used in web based education on success and permanency.* (Unpublished master's thesis). Gazi University Institute of Educational Sciences, Ankara.

*Hall, M. M. (2015). *Traditional vs. technology based math fluency practice and its effect on student achievement and motivation in mathematics. (PhD Dissertation),* the University of St. Francis.

*Hayıroglu, B., & Ulus, L. (2017). The effect of play method on creating pattern ability to children in the preschool educational institution. *PESA International Journal of Social Studies, 3*(3), 77–91.

Hedges, L. V. (1992). Meta-analysis. *Journal of Educational and Behavioral Statistics, 17*(4), 279-296.

*Hsiao, H. S., & Chen, J. C. (2016). Using a gesture interactive game-based learning approach to improve preschool children's learning performance and motor skills. *Computers & Education, 95,* 151-162.

*Hung, C.-M., Huang, I., & Hwang, G.-J. (2014). Effects of digital game-based learning on students' self-efficacy, motivation, anxiety, and achievements in learning mathematics. *Journal of Computers in Education, 1*(2-3), 151–166.

Hwang, G. J., Wu, P. H., & Chen, C. C. (2015). An online game approach for improving students' learning performance in web-based problem-solving activities. *Computers & Education. 59*(1), 1246-1256.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching, 25*(3&4) 1-26. http://celt.miamioh.edu/ject/fetch.php?id=594.

*Kandemir, A. (2019). *Effect Of Play Based Teachıng Materıals On Early Number Development Of Chıldren 48 And 60 Mounts Old.* İstanbul Okan University, İstanbul.

*Kaya, S., & Elgün, A. (2015). The influence of instructional games in science teaching on primary students' achievement. *Kastamonu Journal of Education, 23*(1), 329–342.

*Ke, F. (2008a). Alternative goal structures for computer game-based learning. *Computer-Supported Collaborative Learning, 3*, 429–445.

*King, A. (2011). *Using interactive games to improve math achievement among middle school students in need of remediation. (PhD Dissertation),* George Washington University.

*Kinzie, M. B., & Joseph, D. R. D. (2008). Gender differences in game activity preferences of middle school children: implications for educational game design. *Education Technology Research and Development, 56,* 643-663.

Malta, S. E. (2010). *The effects of educational computer games that used in elementary education on academic achievement.* (Unpublished master's thesis). Sakarya University Institute of Social Sciences, Sakarya.

*Marangoz, D., & Demirtaş, Z. (2017). The effect of mechanical mind games on mental skill levels of primary school second grade students. *Journal of International Social Research, 10*(53), 612–621.

Mullen, B., Muellerleile, P., & Bryant, B. (2001). Cumulative meta-analysis: Aconsideration of indicators of sufficiency and stability. *Personality and SocialPsychology Bulletin*, 27, 1450–1462

Nicolopoulou, A. (1993). Play, cognitive development, and the social world: Piaget, Vygotsky, and beyond. *Human Development, 36*(1), 1-23.

Ocak, M. A. (2013). Use of educational digital games in education. In M. A. Ocak (Eds.), *Educational Digital Games* (pp. 2-18). Ankara: Pegem Academy.

*Öztürk, H. (2018). *The effects of game based learning on young learner's vocabulary growth and retention levels: An experimental investigation.* Unpublished Master's Thesis, Necmettin Erbakan University, Konya.

*Panoutsopoulos, H., & Sampson, D. G. (2012). A study on exploiting commercial digital games into school context. *Educational Technology & Society, 15*(1), 15–27.

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers & Education, 52*, 1-12.

*Ploger, D., & Hecht, S. (2009). Enhancing children's conceptual understanding of mathematics through Chartworld software. *Journal of Research in Childhood Education, 23*(3), 267–277.

Prensky, M. (2001). *Digital game-based learning.* New York: McGraw Hill.

Rosenthal, R. (1991). *Meta-analytic procedures for social research*. Beverly Hills, CA: Sage.

*Starkey, P. L. (2013). *The effects of digital games on middle school students' mathematical achievement. (PhD Dissertation),* Lehigh University.

Sterne J.A, Gavaghan D, Egger M. (2000). Publication and related bias in meta-analysis: power of statistical tests and prevalence in the literature. *J Clin Epidemiol, 53*, 1119–29.

Sterne, J. A., & Harbord, R. M. (2004). Funnel plots in meta analysis. Stata Journal, 4, 127–141.

*Sung, H. Y., & Hwang, G. J. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. *Computers & education, 63*, 43-51.

*Şahin, M. (2015). *The Effect Of Gamıfıed Game Based Learnıng On Students' Achıevements And Attıtudes Towards Scıence*. Unpublished master's thesis, Bahçeşehir University, İstanbul.

*Şimşek, T., Topal, Y., Maden, S., & Şahin, A. (2010). Teaching of the topic 'determinant' using dramatisation method in Turkish lesson of primary second stage. *Journal of National Education, 40*(186), 106–120.

TDK (2020.). Turkish Language Society in the current Turkish dictionary. Access address: https://sozluk.gov.tr/

*Tecen, B. (2018). *The effects of digital gaming based activities on children's learning vowels in preschool sound training*. Unpublished Master's Thesis, Bahçeşehir University, İstanbul.

*Tokgöz, E. Ö. (2017). *Investıgatıon of Effectıveness of The Game Based Learnıng On Fıfth-Grade Students' Achıevement, Retentıon of Knowledge And Attıtude Toward Scıence*. Unpublished master's thesis, Gazi University, Ankara.

Tran, V. D. (2012). Effects of cooperative learning on students at An Giang University in Vietnam. *International Education Studies, 5*(1), 86-99. http://dx.doi.org/10.5539/ies.v5n1p86.

*Tut, E. (2018). *Effect of game-based learning applications in 4th grade science class on students' academic achievement and creative thinking skills.* Unpublished Master's Thesis, Ondokuz Mayıs University, Samsun.

*Türkmen, G. P. & Soybaş, D. (2017). *The Effect Of Gamıfıcatıon Methodology On Students' Achıevements And Attıtudes Towards Mathematıcs.* Erciyes University, Kayseri.

*Usta, N., Işık, A. D., Taş, F., Gülay, G., Şahan, G., Genç, S., et al. (2018). The effect of teaching mathematics with games on the mathematics achievement of secondary school 7th grade students. *Elementary Education Online, 17*(4), 1972–1987.

*Uyanık, Ö., & Alisinanoğlu, F. (2016). The effect of the academic and language skills education program upon 61–66 month old children's cognitive skills early academic and language skills. *Mediterranean Journal of Humanities, 2,* 459–481.

Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational Technology and Society, 8*(2), 54-65.

*Weiss, I., Karamarski, B., & Talis, S. (2006). Effect of multimedia environ-ments on kindergarten children's mathematical achievement and style of learning. *Educational Media International, 43*(1), 3–17.

Yang, T. C. (2012). Building virtual cities, inspiring intelligent citizens: Digital games for developing students' problem solving and learning motivation. *Computers & Education, 59*(2), 365-377.

*Yazıcıoğlu, S. (2017). *The effect of game based activities on academic achievements, motivations and attitudes of sixth grade middle school students: Sample of light and sound unit.* Unpublished Master's Thesis, Giresun University, Giresun.

*Yıldız, E., Şimşek, Ü. & Ağdaş, H. (2018). The effects of educational game-integrated group research method on academic achievement, attitude towards school, and retention of knowledge in teaching regulatory system. *Journal of Turkish Science Education, 15*(3), 91–105.

*Yiğit, A. (2007). *The effect of primary school 2nd grade computer-aided educational math games on success and retention*. Unpublished master's thesis, Çukurova University, Adana.

*Zetou, E., Vernadakis, N., Derri, V., Bebetsos, E. & Filippou, F. (2014). The effect of game for understanding on backhand tennis skill learning and self-efficacy improvement in elementary students. *Procedia-Social and Behavioral Sciences, 152,* 765-771.